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This project concerned developing new logical formalisms for representing information. New formalisms allow us to represent information that we previously could not capture. New reasoning methods allow us to integrate more information and can yield conclusions that were previously unavailable.

One basic method that was developed involves introducing contexts as mathematical objects and developing formal language for describing the relations between sentences true in different contexts. This allows information that arose from different sources to be integrated, taking account of the differences in collection methodologies, uncertainties, differing languages and ontologies, and potential inconsistencies.

The other main thrust was to describe the processes that underly the changes that occur when new information arrives. The representation of counterfactuals, change, and defeasible reasoning was studied. Each of these allow us to capture how new information should make us adjust our current view of the world.

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Basic Research in Knowledge Representation

Final Report

May 1, 1998

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1 Project Summary

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1.1 Elaboration Tolerance

A theory is elaboration tolerant to the extent that new information can be incorporated with only simple changes. The simplest change is conjoining new information. Adding information to a theory should often change some of its consequences, and this requires that some of the reasoning be nonmonotonic.

The group has developed a new version of the situation calculus that allows information to be added easily. In particular new concurrent events can be introduced without modifying the existing descriptions. A preliminary taxonomy of the elaboration tolerance of systems was also developed. Formalisms and systems can be judged on what kinds of new information they can absorb. Relevant papers are [MA96],[McC98],[Cos97a], [Ami97b], [Ami98a], [CM98a].

1.2 Cartesian Counterfactuals

The formal reasoning group has developed a novel way of representing conditional statements, which allows "what-if" reasoning. This method is simple, and focuses on useful counterfactuals in contrast to previous methods that were more general at the expense of usability. Relevant papers are [Cos96],[CM98b],

Conditional and iterative plans. A new method for extending current planning systems so that they can develop conditional and iterative plans.

1.3 Nonmonotonic Reasoning

Our work on non-monotonic reasoning has progressed at both the theoretical and applied levels. The group has developed new methods of capturing defaults or biases, that allow us to more naturally capture the defaults people use. Connections between qualitative defaults and approaches that use quantitative' information, or probabilities have been investigated. This allows systems that have some definite numbers to use these probabilities, while considering other aspects in qualitative terms, which is necessary when the numbers are unavailable, or inapplicable. Relevant papers are [Cos98b], [Cos98d], [Cos98a], [Cos97c], [Cos97b], [Cos98c], [Ami98b], [Ami97a].

1.4 Context

Statements are asserted in some context. In particular, every database has a context in which its assertions make sense. Usually context is treated informally, e.g. the designer of a database says something about its context in the English language manual for the use of the database. However, it is increasingly necessary for computer programs to use several databases and to take into account the different contexts of the databases.

The project is treating the problem in general way, i.e. making a general theory of contexts and their relations. The main mathematical tool is first order logic. The main kind of formula is ist(c,p), which asserts that the proposition p is true in the context c. Relevant papers are [CP98],[MB94],[Buv96b], [Buv96a], [BBM95].

1.5 Human-Level AI

All of the following papers are available on the John McCarthy's web page at http://www-formal.stanford.edu/jmc.

Making Robots Conscious of their Mental States was given at Machine Intelligence 15, 1995 August in Oxford. To appear in the Pro-

ceedings of that workshop.
http://www-formal.stanford.edu/jmc/consciousness.html

The Mutilated Checkerboard in Set Theory was presented at the QED meeting in Warsaw in 1995 July.
http://www-formal.stanford.edu/jmc/checkerboard.html

Modality, si! Modal logic, no! argues that there are better ways, especially for AI, of treating modalities than any kind of modal logic. It will appear in a special issue of Studia Logica devoted to combining logics.
http://www-formal.stanford.edu/jmc/modality.html

Phenomenal Data Mining concerns finding relations between data and phenomena and not just relations within the data. 1996 August 28.
http://www-formal.stanford.edu/jmc/data-mining.html

From Here to Human-level AI 1996 August, is the basis of an invited talk at KR-96 in 1996 November.
http://www-formal.stanford.edu/jmc/human.html

Concepts of Logical AI has a paragraph each about each of approximately 50 concepts. 1996 July 27.
http://www-formal.stanford.edu/jmc/concepts-ai.html

A LOGICAL AI APPROACH TO CONTEXT will appear in a CSLI (Center for Studies in Linguistics and Information) publication.
http://www-formal.stanford.edu/jmc/logical.html

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